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March 28, 2014

Reference No. 055364-00

Mr. Bartolomé J. Caffellias
Remedial Project Manager
United States Environmental Protection Agency - 6SF-RL
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202

Dear Mr. Caffellias:

Re: Crawfish Sample Locations and Bioaccumulation Modeling
Tier 2 Remedial Investigation
Devil's Swamp Lake Site
East Baton Rouge Parish, Louisiana
CERCLA Docket No. 06-04-10

Clean Harbors Environmental Services, Inc. (Clean Harbors), on behalf of Baton Rouge Disposal, LLC (Respondent), submits herein to the U.S. Environmental Protection Agency (EPA) a summary of crawfish sample locations and additional clarification for the Tier 2 Remedial Investigation (RI) at the Devil's Swamp Lake Site in East Baton Rouge Parish, Louisiana (Site). This letter is submitted in response to the EPA correspondence dated January 15, 2014, which included a request for clarification on the crawfish sample locations, the Areas of Investigation (AOIs), and the crawfish home range. In the January 15, 2014 correspondence, the EPA noted that there was no identification of the crawfish trap location and the AOI for each crawfish sample that was submitted to the laboratory for analysis and that crawfish samples were collected outside the boundaries of the identified AOIs. The EPA also requested consideration of the crawfish exposure domain and home range in the risk assessments for the Site.

1.0 Tier 2 Remedial Investigation

The Tier 2 RI is being conducted in accordance with the Unilateral Administrative Order (UAO) for Remedial Investigation/Feasibility Study (RI/FS) of the Devil's Swamp Lake Site (CERCLA Docket No. 06-04-10). The UAO outlines the requirements for completion of the RI/FS for the Site.

In a letter dated May 24, 2012, the EPA approved the review comment responses on the Draft Tier 2 RI Work Plan and requested submittal of a Final Tier 2 RI Work Plan that incorporated all the requested clarifications and revisions. The Final Tier 2 RI Work Plan was submitted on June 25, 2012, and included a proposed scope of work for crawfish sample collection and analysis to evaluate potential risk to human health and ecological receptors posed by ingestion of benthic invertebrates at the Site.



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Throughout the completion of the Tier 2 RI sample collection effort, the EPA emphasized the importance of an expedited project schedule and consistently requested additional and frequent efforts to collect crawfish samples for use in the Tier 2 RI risk assessments.

2.0 Crawfish Sample Collection

The Tier 2 RI sample collection activities were initiated in July 2012 and crawfish sample collection was not successful due to the Site conditions encountered at that time. Clean Harbors continued to monitor Site conditions including Mississippi River water elevation, temperature, and duration of inundation to evaluate potential suitability for crawfish sample collection. Representatives of the EPA, Louisiana Department of Environmental Quality (LDEQ), Clean Harbors and CRA participated in a conference call on January 24, 2013, to discuss the proposed plan to monitor the availability of crawfish in Devil's Swamp. Clean Harbors agreed to do weekly visual evaluations of the lake and swamp conditions and to set and bait approximately 12 crawfish traps every two weeks to monitor the availability of crawfish for sample collection in accordance with the Final Tier 2 RI Work Plan.

Clean Harbors and CRA set and baited approximately 12 crawfish traps in the northern portion of Devil's Swamp Lake and the North-Central Devil's Swamp areas from February 2013 throughout March 2013. The traps were pulled and checked for crawfish on a weekly basis, and no crawfish were collected. At the end of March, no crawfish were observed in the crawfish traps set and baited in the northern portion of Devil's Swamp Lake and the North-Central Devil's Swamp areas. The traps were baited again and several of the traps were moved to different locations throughout the month of April to determine better crawfish sample location areas. In April 2013, several traps were moved due to the drop in water levels in the North Central Devil's Swamp, which left the set crawfish traps on dry ground. Due to the lack of success in the North Central Devil's Swamp and Devil's Swamp Lake areas, the history of crawfish sample collection difficulties in these areas, and the schedule pressure to obtain crawfish results; the sampling crew began moving traps to the west and south based on water levels, water conditions, and a more favorable habitat (food source). Advice about favorable habitat conditions, bait options, and trap placement was obtained from experienced area crawfishermen that fish areas similar to Devil's Swamp.

On April 29, 2013, approximately 47 crawfish traps were baited. The traps were checked on May 1, 2013, and a total of 63 crawfish were observed and released. The traps were checked for crawfish again on May 6, 2013, and a total of 50 crawfish were observed and released. On May 9, 2013, representatives of Clean Harbors, CRA, and EA Engineering, Science, and Technology (EA) checked 47 crawfish traps. A total of 46 crawfish were collected and placed in a freezer for accumulation prior to sample shipment to the laboratory. Evidence of low oxygen levels in the lake and swamp water was observed during this sample collection event. Crawfish were noted at the top of the traps trying to get oxygen and the water was noted to have a darker color and minimal to no water movement.

On May 13, 2013, representatives of Clean Harbors, CRA, EA, and Louisiana Department of Environmental Quality (LDEQ) checked the traps and approximately 75 crawfish were collected. The crawfish were combined with those collected on May 9, 2013, and one crawfish sample was submitted to TestAmerica for analysis in accordance with the EPA-approved Final Tier 2 RI Work Plan. EA collected

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a split sample for submittal and analysis by the EPA laboratory. Crawfish sample collection efforts by Clean Harbors, CRA, and LDEQ continued on May 15, 2013, and May 17, 2013, and approximately 180 crawfish were collected and 3 samples were submitted to the lab for analysis on May 20, 2013. On May 20, 2013, representatives of Clean Harbors, CRA, and LDEQ continued crawfish sample collection and 237 crawfish were collected. Clean Harbors, CRA and EA checked the traps on May 22, 2013, and 249 crawfish were collected and 6 samples were submitted to the lab for analysis. On May 24, 2013, approximately 261 crawfish were collected.

On May 28, 2013, representatives of Clean Harbors, CRA, and LDEQ checked the traps again and collected 358 crawfish. On May 28, 2013, 5 crawfish samples were submitted to the lab for analysis, which completed the 15 total samples proposed in the Final Tier 2 RI Work Plan. Clean Harbors and CRA dissected approximately 350 crawfish to extract the hepatopancreas tissue for separate analysis by the lab. Four additional samples were submitted to the lab for separate analysis of the crawfish hepatopancreas tissue and the tail meat in accordance with the LDEQ request for the fishing advisory. Clean Harbors and CRA confirmed this sample preparation approach with the LDEQ. The remainder of the crawfish whole body (including the tail shell) for the four additional samples was weighed by the lab for reference.

Representatives of Clean Harbors, CRA, LDEQ, and EA participated in the crawfish sample collection activities from February 2013 through May 2013. Documentation of the weekly crawfish sample collection attempts and activities were submitted to the EPA in weekly email updates and monthly progress reports. Throughout the Tier 2 RI sample collection activities, the EPA emphasized the importance of continued crawfish sample collection effort and expedited schedule.

3.0 Crawfish Sample Locations

The EPA requested submittal of the final crawfish sampling locations by email on October 23, 2013. On November 7, 2013, Clean Harbors submitted a correspondence that summarized the Tier 2 RI crawfish sample collection activities and a map showing the approximate crawfish trap locations. Attached Figure 1 shows all the trap locations where crawfish sampling was attempted from January 2013 through May 2013. The crawfish traps were relocated throughout the sampling activities and the figure shows all the attempted sample collection locations. The crawfish samples submitted to the laboratory for analyses were collected primarily from the traps located in the swamp to the west of Devil's Swamp Lake and in the South Bayou Baton Rouge area. When significant numbers of crawfish were observed in the traps in May 2013, each crawfish trap was assigned a number in order for the field team to record the number of crawfish collected from each trap. Table 1 shows the number of crawfish collected on each collection day in May 2013 and the total number of crawfish collected from each trap throughout the sampling activities.

On January 15, 2014, the EPA submitted a correspondence in response to the Clean Harbors crawfish sample location submittal that requested clarification on the crawfish sample locations, the Areas of Investigation (AOIs), and the crawfish home range. The EPA noted that there was no identification of the crawfish traps location and the corresponding AOI for each crawfish sample that was submitted to



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the laboratory for analysis and that crawfish samples were collected outside the boundaries of the identified AOIs. The EPA also requested consideration of the crawfish exposure domain and home range in the risk assessments for the Site.

In May 2013, crawfish were collected from over 60 traps located across the Site as shown on Figure 1. Each composite crawfish sample consisted of approximately 40-60 individual crawfish. Therefore, the precise location of each crawfish sample was not able to be recorded. The number of crawfish collected from each trap on each sample date was recorded in the field log book and is shown in Table 1. The crawfish were then combined to form a composite sample for analysis, as the laboratory needed approximately 75 grams of edible crawfish tissue to conduct the requested analyses. As cited above, the crawfish samples submitted to the laboratory for analyses were collected primarily from the traps located in the swamp to the west of Devil's Swamp Lake and in the South Bayou Baton Rouge area. There were no crawfish observed in traps located in the North-Central Devil's Swamp and the Devil's Swamp Lake AOIs. Figure 1 shows the approximate number of crawfish observed in each trap throughout the duration of the crawfish sample collection attempts from January through May 2013. Following several months of attempted crawfish trapping within the boundary of the Site AOIs, additional traps were set in the swamp and bayou areas adjacent to the Site to obtain the necessary volume of crawfish for sample collection and analysis by the laboratory.

4.0 Crawfish Habitat

Numerous environmental factors affect the activity patterns and dynamics of crawfish populations, including water temperature and quality, water elevation, ambient air temperature, and vegetative cover. A plot of the Mississippi River water elevation, as recorded at the Baton Rouge gage, is attached as Figure 2. A Mississippi River stage of above approximately 22 feet is required for the lower portions of the North-Central Devil's Swamp AOI to be inundated. Although crawfish can be observed year round, their overall activity is seasonal. In southern states, including Louisiana, spring flooding triggers reproductive activities. With spring flooding and warm temperatures, crawfish emerge from their burrows and typically breed in May and June. Following mating, female crawfish return to their burrow where development of the eggs occurs over a period of 2 to 5 months.

Crawfish tend to burrow in the banks around the perimeter of water bodies, rather than in the substrate of open water. The burrows are characterized by high humidity's and several inches of "wet slush." The burrows are typically in areas of standing vegetation. Developing young and adults tend to remain in burrows from June through October.¹ This dormancy period can be impacted significantly by ambient temperature and water conditions (temperature, depth, and quality).

The 2012 and 2013 Tier 2 RI trapping program for Devil's Swamp Lake was consistent with the above description of the overall activity patterns of crawfish. Available information indicates that the EPA had

¹ The discussion in this section is based on information presented in the *Crawfish Production Manual* prepared by the Louisiana State University Agricultural Center (revised July 1999) and *Production of Crawfish in Alabama* prepared by Alabama Cooperative Extension System, ANR -891.



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similar issues collecting crawfish from specific areas in Devil's Swamp Lake in the 1990s, presumable due to the habitat specifics outlined above. Although no crawfish were ever observed in the traps located in the Drainage Ditch and Devil's Swamp Lake, traps in other areas had limited trapping success from July through December 2012 and from January through early May 2013. The peak in trapping success most likely corresponded with the onset of reproductive activities, which was in turn triggered by water elevation and ambient temperatures.

5.0 Ecological Risk Assessment

The *Step 3 - Problem Formulation Report for the BERA* was completed and submitted to the EPA and LDEQ on February 10, 2012. The refinement process identified a potential for risk to:

- Benthic invertebrates exposed to PCB aroclors in sediment of the Drainage Ditch AOI and North Devil's Swamp Lake AOI
- Avian and mammalian insectivores exposed to PCB aroclors and congeners in sediment in all four AOIs
- Mammalian herbivores exposed to sediment of the North Devil's Swamp Lake AOI
- Avian and mammalian piscivores exposed to sediment in the Drainage Ditch AOI
- Mammalian Insectivores exposed to soil in the Drainage Ditch AOI
- Mammalian herbivores exposed to soil in the Drainage Ditch AOI

As outlined in the EPA-approved Final Tier 2 RI Work Plan, the data collection program for the Tier 2 RI and BERA addressed the exposure pathways and the avian and mammalian receptors identified above. As discussed with the EPA and LDEQ on November 9, 2011, the BERA is not intended to address risk to benthic invertebrate communities. Due to the relatively high degree of uncertainty in the calculation of PCB concentrations in benthic invertebrates and fish, the Tier 2 RI and BERA included collection and analysis of invertebrates (crawfish) and fish (catfish and largemouth bass) for whole body concentrations of PCBs. The data will be used to re-evaluate the potential of risk to avian and mammalian insectivores and piscivores, even if the analyses presented in the Problem Formulation Report did not identify a potential for risk.

Crawfish samples were collected Site-wide for use in the food chain models, not to evaluate risk to crawfish or other benthic organisms. The indicator species for the food chain models (bald eagle, great blue heron, belted kingfisher, mink, and raccoon) forage throughout the Devil's Swamp Lake area, both within and contiguous to the AOIs. Consequently, exposure should consider all areas adjacent to the AOIs where the indicator species forage, not only the AOIs. As requested by the EPA and United States Fish and Wildlife Service (USFWS) and proposed in the approved Tier 2 RI Work Plan, the BERA will evaluate risk for the entire Site, not the individual AOIs.

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6.0 Bioaccumulation Modeling and Human Health Risk Assessment

Representatives of EPA, LDEQ, Louisiana Department of Health and Hospitals (LDHH), Clean Harbors, and CRA participated in a conference call to discuss the Tier 2 RI crawfish sample locations on February 13, 2014. Although the collection of any measurable quantity of crawfish from the Site-specific AOIs was an issue both historically and during the Tier 2 RI sample collection period, there was concern expressed about the representativeness of the crawfish samples because they were not collected from the AOIs with identified sediment impact for use in the human health risk assessment. To further consider the risk calculation uncertainties potentially associated with the difficulty in crawfish sample collection and at the request of EPA, Clean Harbors agreed to complete sediment to crawfish tissue bioaccumulation modeling to estimate theoretical exposure concentrations for human receptors that may ingest crawfish within Devil's Swamp Lake and the immediate surrounding swamp areas. On February 24, 2014, EPA submitted a follow-up email requesting a separate submittal outlining the Site-specific bioaccumulation modeling approach and results for review. EPA, Clean Harbors, and CRA participated in an additional conference call on February 26, 2014, to discuss the format for submittal of the bioaccumulation modeling results.

Sediment to biota accumulation factors (BSAFs) were calculated using Site-specific data including crawfish tissue sample concentrations obtained from South Bayou Baton Rouge, lipid content, sediment sample concentrations, and sediment organic carbon (OC). The Site-specific BSAFs were used to calculate theoretical crawfish exposure concentrations for the individual AOIs (Drainage Ditch, North Devil's Swamp Lake, North-Central Devil's Swamp, South Devil's Swamp Lake, and South Bayou Baton Rouge). The estimated crawfish exposure concentrations (tails only) will be used to assess the potential uncertainty in the calculation of adverse effects on human health associated with hypothetical recreational collection and consumption of this potential food item. The difficulties in actually collecting any crawfish in these areas would be realized by the craw fisherman and may be relevant to the risk calculations, but the modeling evaluation can provide context for the uncertainty associated with the data collection difficulties. The poor recovery of crawfish expected in these areas make the modeling results conservative for use in the calculation of potential risk. The evaluation of potential human health risk from consumption of crawfish will focus on the individual AOIs at the Site.

A Technical Memorandum that includes a summary of the bioaccumulation modeling approach and results is included in Attachment A.

7.0 Reporting

Following the EPA review of the bioaccumulation modeling approach, Clean Harbors plans to incorporate the results in the Human Health Risk Assessment and present an evaluation of the results in the Tier 2 RI Report.



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Should you have any questions or require additional information regarding this submittal, please contact John Arbuthnot at (225) 778-3596.

Yours truly,

A handwritten signature in black ink, appearing to read "J.C. Arbuthnot", with a long, sweeping horizontal line extending from the end of the signature.

John C. Arbuthnot, PE
Senior Remediation Manager
Clean Harbors Environmental Services, Inc.
On behalf of:
Baton Rouge Disposal, LLC

Encl. Figures
 Table
 Attachment A - Summary of the Bioaccumulation Modeling Approach and Results

cc: *via e-mail*: Keith Horn, Louisiana Department of Environmental Quality
 Mark Paddack, EA Engineering, Science, and Technology
 Pressley L. Campbell, Conestoga-Rovers & Associates
 Darcie Olexia, Louisiana Department of Health and Hospitals
 Barry Forsythe, U.S. Fish and Wildlife Service

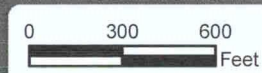
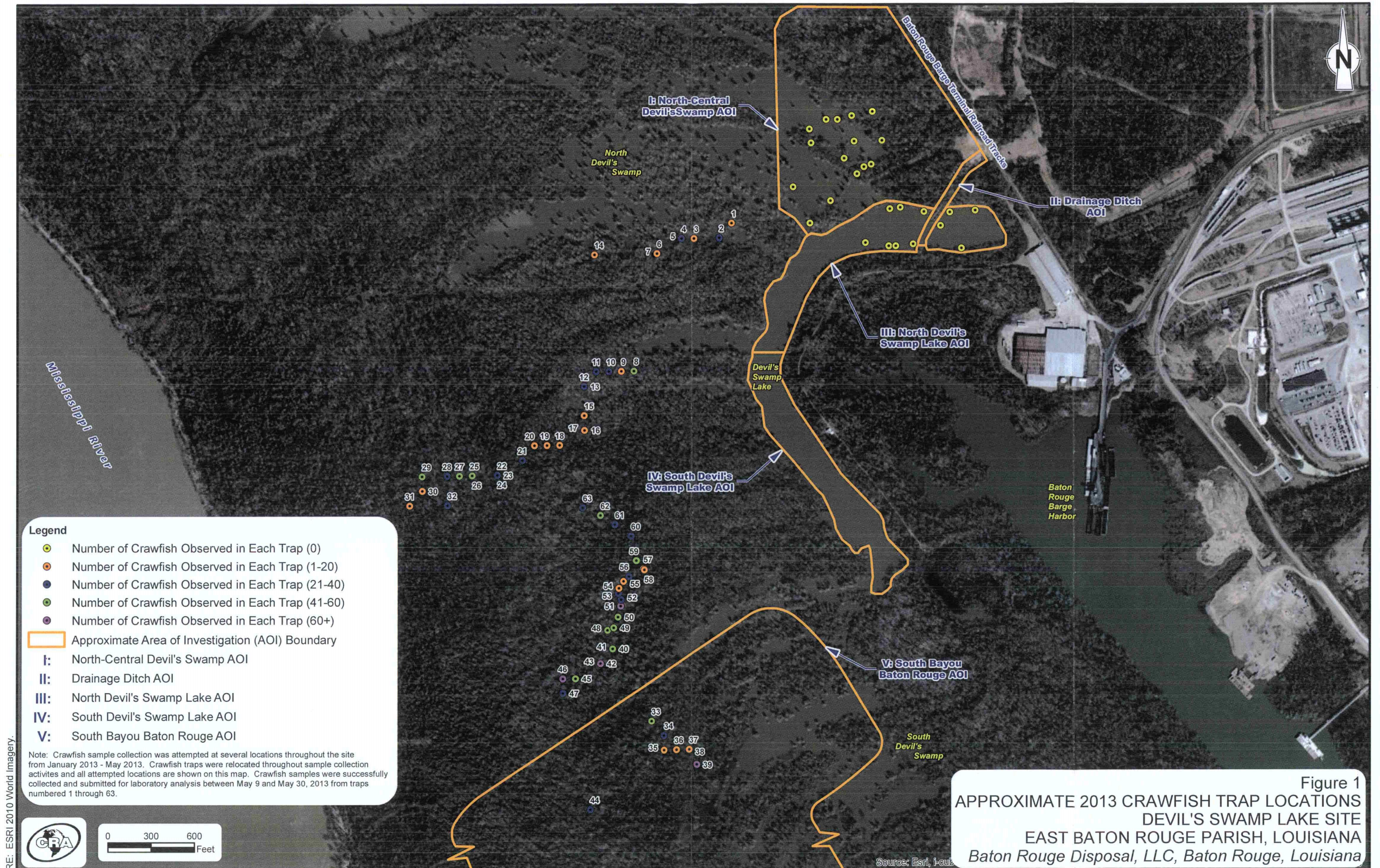


FIGURE 2
RIVER STAGE VS. TIME - JANUARY THROUGH JUNE 2013
DEVIL'S SWAMP LAKE SITE
EAST BATON ROUGE PARISH, LOUISIANA

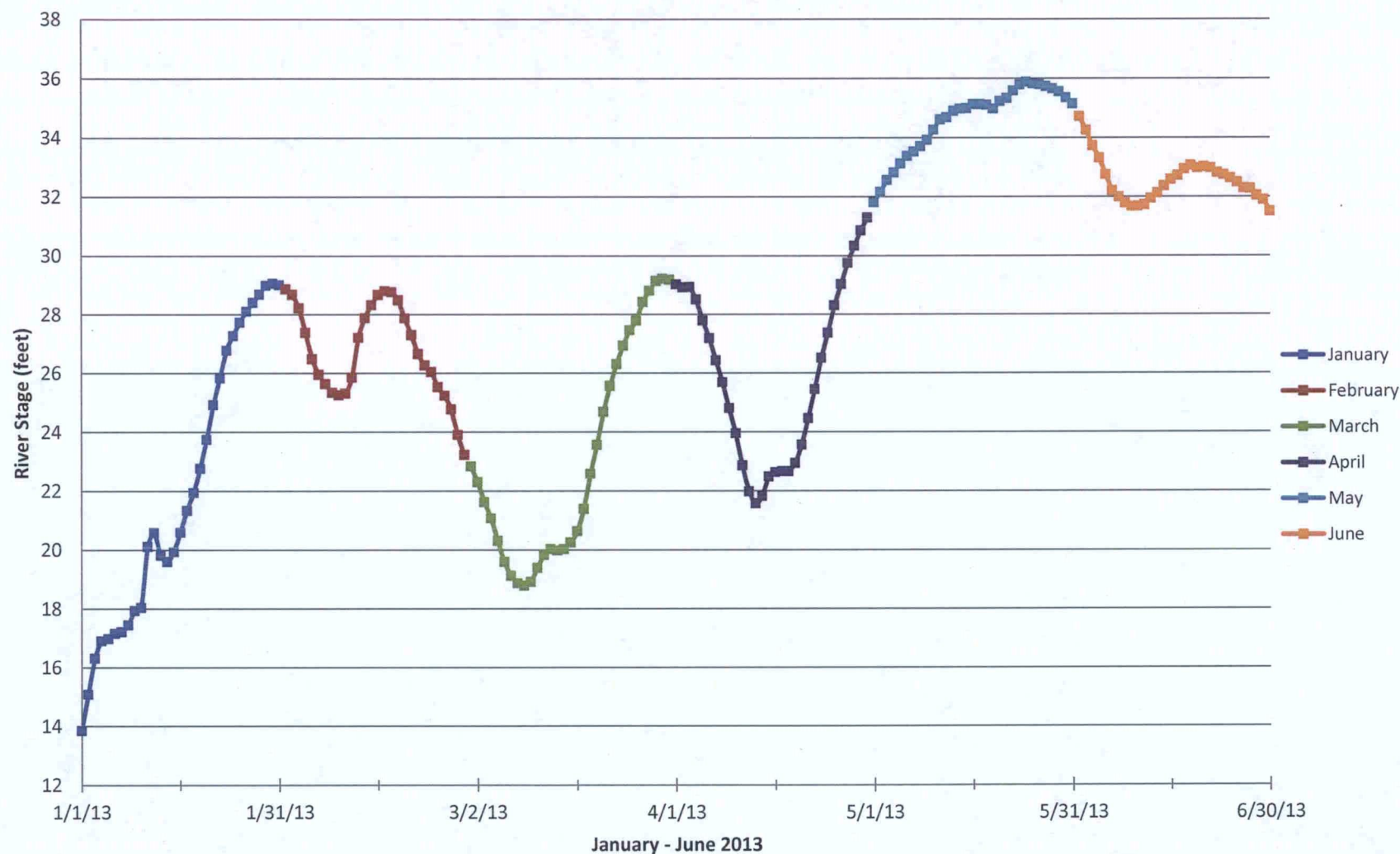


TABLE 1
NUMBER OF CRAWFISH CAUGHT PER CRAWFISH TRAP
TIER 1 REMEDIAL INVESTIGATION
DEVIL'S SWAMP LAKE SITE
EAST BATON ROUGE PARISH, LOUISIANA

Crawfish Trap No.	No. of Crawfish on 5/9/13	No. of Crawfish on 5/13/13	No. of Crawfish on 5/15/13	No. of Crawfish on 5/17/13	No. of Crawfish on 5/20/13	No. of Crawfish on 5/22/13	No. of Crawfish on 5/24/13	No. of Crawfish on 5/28/13	No. of Crawfish on 5/30/13	Total No. of Crawfish Collected in Each Trap
1	1	3	2	0	0	1	1	0	3	11
2	1	2	0	1	1	3	2	6	5	21
3	2	3	0	0	0	1	0	0	3	9
4	1	4	0	0	1	0	1	0	1	8
5	3	1	1	0	3	5	0	2	6	21
6	0	8	1	0	0	0	0	0	0	9
7	0	0	0	0	0	1	0	0	0	1
8	8	8	7	2	4	5	5	6	12	57
9	0	4	0	1	1	1	1	2	5	15
10	0	3	2	2	1	4	5	4	3	24
11	6	3	7	3	1	0	1	4	4	29
12	3	2	4	6	6	7	6	13	10	57
13	1	4	3	5	2	3	1	3	9	31
14	0	3	2	0	1	0	1	9	0	16
15	0	2	0	1	0	0	1	1	0	5
16	0	0	2	1	3	3	9	9	5	32
17	1	1	0	0	2	0	0	1	2	7
18	0	0	2	0	0	0	1	0	3	6
19	0	1	0	0	0	0	1	0	2	4
20	0	0	0	2	0	1	0	1	2	6
21	1	0	0	3	10	2	3	3	5	27
22	0	1	2	4	4	2	9	10	19	51
23	1	1	2	2	3	4	5	3	11	32
24	0	0	1	2	4	8	3	3	4	25
25	0	0	2	1	4	2	2	7	19	37
26	0	1	1	2	3	6	4	11	22	50
27	1	0	3	3	3	4	5	2	21	42
28	0	0	0	3	6	2	2	7	10	30
29	1	1	1	1	8	5	6	8	17	48
30	0	0	0	1	0	0	1	3	3	8
31	0	0	1	0	0	0	1	1	2	5
32	0	0	4	1	1	3	4	7	8	28
33	1	3	5	2	8	12	8	4	17	60
34	3	1	1	3	3	3	5	5	7	31
35	0	1	1	1	0	0	0	0	1	4
36	0	1	1	1	0	0	1	1	0	5
37	2	0	0	3	3	1	5	3	4	21
38	0	1	2	1	0	0	2	1	2	9
39	1	3	2	6	5	4	9	24	17	71
40	6	5	7	3	3	4	6	2	15	51
41	1	1	4	4	5	6	5	13	14	53
42	0	1	6	8	9	13	8	13	31	89
43	1	0	2	3	4	9	15	14	23	71
44	0	0	0	1	1	7	7	12	10	38
45	0	1	4	3	4	9	4	10	20	55
46	0	0	2	5	6	9	7	17	16	62
47	0	1	2	0	5	1	3	5	22	39
48	N/A	N/A	N/A	N/A	11	7	11	5	15	49
49	N/A	N/A	N/A	N/A	9	9	4	11	11	44
50	N/A	N/A	N/A	N/A	14	6	7	8	12	47
51	N/A	N/A	N/A	N/A	14	13	14	18	21	80
52	N/A	N/A	N/A	N/A	6	6	6	8	6	32
53	N/A	N/A	N/A	N/A	4	11	6	0	14	35
54	N/A	N/A	N/A	N/A	5	5	0	2	5	17
55	N/A	N/A	N/A	N/A	2	0	0	1	2	5
56	N/A	N/A	N/A	N/A	3	2	1	13	16	35
57	N/A	N/A	N/A	N/A	4	3	1	4	8	20
58	N/A	N/A	N/A	N/A	8	3	1	0	4	16
59	N/A	N/A	N/A	N/A	8	8	8	10	13	47
60	N/A	N/A	N/A	N/A	4	3	8	6	6	27
61	N/A	N/A	N/A	N/A	0	13	11	1	13	38
62	N/A	N/A	N/A	N/A	9	5	12	12	21	59
63	N/A	N/A	N/A	N/A	8	4	5	9	13	39
Totals	46	75	89	91	237	249	261	358	595	2001

Notes:

1-20	21-40	41-60	60+
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Attachment A

Summary of the Bioaccumulation Modeling Approach and Results

Attachment A

Summary of the Bioaccumulation Modeling Approach and Results Tier 2 Remedial Investigation Devil's Swamp Lake Site East Baton Rouge Parish, Louisiana

Overview

This Technical Memorandum includes a summary of the calculation of theoretical exposure concentrations in crawfish tissue for use in the risk assessments currently being conducted for the Devil's Swamp Lake Superfund Site (Site) in East Baton Rouge Parish, Louisiana. In May 2013, crawfish samples were collected from swamp and marsh areas adjacent to the Site. Crawfish samples were analyzed for 209 congeners of polychlorinated biphenyls (PCBs) in accordance with the EPA-approved work plan. Despite an effort to collect crawfish within the defined boundaries of the Site, the majority of successful sampling areas were located outside and adjacent to the identified Site Areas of Investigation (AOIs). Although the difficulties in collecting crawfish from certain AOIs is expected given the less favorable habitat, crawfishermen would not be expected to continue to push for the collection of crawfish in unsuccessful areas. Therefore, future efforts to collect crawfish in these areas would likely result in a similar outcome. The United States Environmental Protection Agency (EPA) and Louisiana Department of Environmental Quality (LDEQ) have expressed concern that, due to the limited mobility of crawfish, concentrations of PCBs in the crawfish collected from areas adjacent to the Site may not be representative of exposure concentrations within the assessment area or the individual AOIs. At the request of EPA, Clean Harbors agreed to complete sediment to crawfish tissue bioaccumulation modeling to further consider the possible uncertainty in the risk calculations by determining an estimate of theoretical exposure concentrations for human receptors that may ingest crawfish within Devil's Swamp Lake and the immediate surrounding swamp areas.

While this approach can be used in the absence of actual sample tissue data from the Site, the theoretical exposure concentrations for the individual AOIs (especially for the Drainage Ditch, North Devil's Swamp Lake and South Devil's Swamp Lake) may overestimate the potential human health risk posed by the benthic invertebrate communities. These AOIs do not represent the typical crawfish habitat areas, which was evident during the Tier 2 RI sampling effort and is supported by literature. The description of previous crawfish sampling effort by EPA during the 1990s implied similar observations regarding the lack of crawfish available in Devil's Swamp Lake and more availability in the surrounding areas of Devil's Swamp. The Drainage Ditch and Devil's Swamp Lake are not typical areas that would be used by recreational or commercial crawfishermen. In addition, the North-Central Devil's Swamp AOI habitat (vegetation, elevation, and shorter less frequent inundation) also varies in favorability for crawfish.

Data from the 2013 Tier 2 Remedial Investigation (RI) sampling program, coupled with sediment sample data collected in 2011 and 2012 during both the Tier 1 and Tier 2 RI, are sufficient to develop sediment to biota accumulation factors (BSAFs) for the 12 dioxin-like PCBs (DLPCBs) identified by the World Health Organization (WHO) and total PCBs. The Site-specific BSAFs for DLPCBs and total PCBs can be used to calculate theoretical exposure concentrations for the individual AOIs (Drainage Ditch, North Devil's

Attachment A

Summary of the Bioaccumulation Modeling Approach and Results Tier 2 Remedial Investigation Devil's Swamp Lake Site East Baton Rouge Parish, Louisiana

Swamp Lake, North-Central Devil's Swamp, South Devil's Swamp Lake, and South Bayou Baton Rouge). The methods for calculating the Site specific BSAFs and estimated exposure concentrations for the five AOIs are discussed below.

Methodology

Crawfish collected in 2013 included a number of successful traps from the South Bayou Baton Rouge AOI. Because crawfish samples for laboratory analysis were composited from all successful traps (west and south of Devil's Swamp Lake including South Bayou Baton Rouge), it is not possible to identify those crawfish specifically collected from South Bayou Baton Rouge. Consequently, concentrations of PCBs in crawfish used to develop the BSAFs are based on the 15 composite crawfish samples analyzed in 2013.

For each of the 15 composite samples, tail tissue was removed from the individual crawfish. Tail tissue and offal (the remaining portion of the crawfish after tail tissue is removed) were analyzed separately. Offal and tail tissue were analyzed for 209 PCB congeners, as well as percent lipid. Whole body concentrations were calculated by adding the weighted concentrations in tail tissue and offal. For each sample, concentrations of PCBs were summed to produce concentrations of DLPCBs and total PCBs for that sample. For DLPCBs, only the 12 WHO DLPCBs were summed. For DLPCBs, a toxic equivalency quotient (TEQ) was calculated for each sample. This was accomplished by multiplying the concentration of each of the 12 DLPCBs by its toxicity equivalency factor (TEF) for human (mammalian) receptors and summing the products to produce a toxicity equivalency quotient (TEQ) for each sample.

For total PCBs, the concentrations of those congeners that co-elutriate were summed and treated as a single congener. This reduced the number of congeners from 209 to 162, which were then summed to produce a concentration of total PCBs for each sample. For the summation process, those congeners that were not detected in any sample were assigned a concentration of zero. Some congeners were detected in some samples, but not in all 15 samples. Congeners were assigned a concentration equal to the reported value if detected; and equal to one-half the detection limit if not detected.

Five sediment samples collected from South Bayou Baton Rouge were analyzed for the 12 WHO DLPCBs. Eleven samples were analyzed for PCB aroclors. All sediment samples were analyzed for organic carbon (OC). The method for calculating sediment concentrations for the 12 DLPCBs was the same as was done for crawfish, including the calculation of a TEQ for each sample. Total PCBs were calculated by summing the aroclors for each sample. For the summation process, those aroclors that were not detected in any sample were assigned a concentration of zero. Some aroclors were detected in some samples, but not in all 15 samples. Aroclors were assigned a concentration equal to the reported value if detected; and equal to one-half the detection limit if not detected.

Attachment A

Summary of the Bioaccumulation Modeling Approach and Results Tier 2 Remedial Investigation Devil's Swamp Lake Site East Baton Rouge Parish, Louisiana

BSAFs were calculated for DLPCB TEQs for human receptors and total PCBs as:

$$BSAF = (C_{crawfish}/f_{lipid})/(C_{sediment}/f_{oc}) \quad \text{Equation 1}$$

Where:

BSAF	=	Sediment to Biota Accumulation Factor (unitless)
$C_{crawfish}$	=	Concentration of PCBs in crawfish (mg/kg wet weight)
f_{lipid}	=	Fraction of lipid in crawfish (unitless)
$C_{sediment}$	=	Concentration of PCBs in sediment (mg/kg dry weight)
f_{oc}	=	Fraction of organic carbon in sediment (unitless).

As identified in the above equation, concentrations in crawfish were normalized for fraction of lipid in tail tissue and whole body and sediment was normalized for fraction of OC in sediment.

The values for $C_{crawfish}$ and f_{lipid} entered into Equation 1 are the geometric means for the 15 composite samples. The values for $C_{sediment}$ and f_{oc} are the geometric means of these parameters for South Bayou Baton Rouge, where a portion of the crawfish was collected.

Table 1 identifies the values for the input parameters in Equation 1.

Table 1 Input Parameters for Calculation of BSAFs		
<i>Input Parameter</i>	<i>DLPCB TEQs</i>	<i>Total PCBs</i>
Sediment		
$C_{sediment}$ (mg/kg DW)	0.000000088	0.0087
f_{oc} (unitless)	0.0224	0.0224
Whole Crawfish		
$C_{crawfish}$ (mg/kg WW)	0.00000094	0.0102
f_{lipid} (unitless)	0.0178	0.0178
Tail Tissue		
$C_{crawfish}$ (mg/kg WW)	0.0000011	0.0025
f_{lipid} (unitless)	0.0012	0.0012

The BSAFs calculated using Equation 1 were used to develop theoretical exposure concentrations for each of the AOIs. Concentrations of PCBs in crawfish were calculated by rearranging Equation 1 to:

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$$C_{crawfish} = BSAF * (f_{lipid}) / (f_{oc} / C_{sediment})) \quad \text{Equation 2}$$

The BSAFs and values for f_{lipid} were assumed to be constant for all AOIs. Values for f_{oc} were the geometric means of samples from the individual AOIs. Exposure concentrations were calculated for reasonable maximum exposure (RME) and central tendency (CT) scenarios. For the RME scenario, 95% upper confidence limit (UCL) concentrations were calculated for $C_{sediment}$ using ProUCL, Version 5.0 (USEPA 2013). The maximum concentration was used for the RME if the 95% UCL was greater than the maximum concentration. The arithmetic mean was used for $C_{sediment}$ for the CT scenario. Table 2 identifies the values for f_{oc} and $C_{sediment}$ for the RME and CT scenarios.

Table 2 Input Parameters for f_{oc} and $C_{sediment}$			
<i>AOI</i>	f_{oc}	$C_{sediment}$ (mg/kg)	
		<i>DLPCB TEQs</i>	<i>Total PCBs</i>
Reasonable Maximum Exposure			
Drainage Ditch	0.0013	0.000067	1.0590
North Devil's Swamp Lake	0.0085	0.000023	1.6330
North-Central Devil's Swamp	0.0114	0.000018	0.1730
South Devil's Swamp Lake	0.0132	0.000012	0.1690
South Bayou Baton Rouge	0.0224	0.0000023	0.0343
Central Tendency			
Drainage Ditch	0.0013	0.000030	0.7040
North Devil's Swamp Lake	0.0085	0.000012	0.8220
North-Central Devil's Swamp	0.0114	0.0000078	0.0701
South Devil's Swamp Lake	0.0132	0.0000069	0.1100
South Bayou Baton Rouge	0.0224	0.0000012	0.0191

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Results

Table 3 identifies the BSAFs calculated for DLPCB TEQs for human receptors and total PCBs for whole crawfish and tail tissue.

Table 3 Sediment to Biota Accumulation Factors		
	<i>DLPCB TEQs</i>	<i>Total PCBs</i>
Whole Crawfish	1.34	1.47
Tail Tissue	22.9	5.61

The Site-specific BSAFs for whole crawfish calculated for the Devil's Swamp Lake Site are similar to those reported by Kay, et al. (2005). The sediment to whole crawfish BSAFs are 0.429 for the Kalamazoo River Area of Concern and 2.37 for the upstream (uncontaminated) Fort Custer State Recreation Area. As was done for Devil's Swamp, the BSAFs reported by Kay, et al. (2005) were based on lipid normalization of crawfish concentrations, OC normalization of geometric mean of sediment concentrations, wet weight concentrations for crawfish tissue, and dry weight concentrations for sediment. Kay, et al. (2005) did not calculate BSAFs for tail tissue.

Table 4 summarizes the calculated exposure concentrations for DLPCB TEQs for human receptors in whole crawfish and tail tissue for the five AOIs.

Table 4 Exposure Concentrations for DLPCB TEQs (mg/kg)					
<i>Scenario</i>	<i>Drainage Ditch</i>	<i>North Devil's Swamp Lake</i>	<i>North-Central Devil's Swamp</i>	<i>South Devil's Swamp Lake</i>	<i>South Bayou Baton Rouge</i>
Whole Crawfish					
RME	0.00127	0.0000654	0.0000375	0.0000212	0.00000240
CT	0.00057	0.000031	0.000016	0.000012	0.0000013
Tail Tissue					
RME	0.00141	0.0000729	0.0000419	0.0000236	0.00000292
CT	0.000639	0.0000372	0.0000181	0.0000139	0.00000140

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Table 5 summarizes the calculated exposure concentrations for total PCBs in whole crawfish and tail tissue for the five AOIs.

Table 5 Exposure Concentrations for Total PCBs (mg/kg)					
<i>Scenario</i>	<i>Drainage Ditch</i>	<i>North Devil's Swamp Lake</i>	<i>North-Central Devil's Swamp</i>	<i>South Devil's Swamp Lake</i>	<i>South Bayou Baton Rouge</i>
Whole Crawfish					
RME	22.1	5.04	0.397	0.334	0.0402
CT	14.7	2.54	0.161	0.218	0.0224
Tail Tissue					
RME	5.48	1.25	0.0984	0.0830	0.00997
CT	3.65	0.629	0.0399	0.0540	0.00555

For comparison, the 1999 Human Health Risk Assessment conducted for the larger Devil's Swamp area identified exposure point concentrations of 0.641 mg/kg for whole crawfish for the RME scenario and 0.0544 mg/kg for the CT scenario. For tail tissue, the exposure point concentrations are 0.155 mg/kg and 0.0899 for the RME and CT scenarios, respectively. For both whole body and tail tissue, the calculated exposure concentrations are greater than reported in the 1999 HHRA for the RME scenario for the Drainage Ditch and North Devil's Swamp Lake AOIs. For whole body tissue, the calculated exposure concentrations are lower than reported in the 1999 HHRA for the RME scenario for the North-Central Devil's Swamp, South Devil's Swamp Lake, and South Bayou Baton Rouge AOIs. For tail tissue, the calculated exposure concentrations are lower than reported in the 1999 HHRA for the RME scenario and the CT scenario for North-Central Devil's Swamp, South Devil's Swamp Lake, and South Bayou Baton Rouge.

References

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